agri-fax Alberta AGRICULTURE

Agdex 541-1

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Alberta Fertilizer Guide

The purpose of this guide is to provide information on the use of fertilizers under the various cropping and soil-climate conditions throughout the province. Since the nutrient requirements of crops and the ability of soils to supply them vary widely, fertilizer recommendations (Tables 3 & 4) are given as a range of application rates typical of a particular crop and soil-climatic area. Factors to consider when choosing application rates for specific situations are discussed in the guide. Farmers are encouraged to use the fertilizer guide in conjunction with soil tests and their own experience to develop an effective and economic fertilizer program.

Soils, Cropping Practices, and Fertilizer Use

General

Nitrogen and **phosphorus** are the two nutrients most commonly limiting crop yields in Alberta. For crops grown on fallow, phosphorus may be the only nutrient limiting crop yield. Crop-fallow rotations rely heavily on nitrogen released from the mineralization of soil organic matter. As a result of frequent fallowing, soil organic matter levels can decline to a point where nitrogen fertilization is required to maintain yields of crops grown on fallow.

When the frequency of cropping is extended to crop-crop-fallow or approaches continuous cropping, nitrogen becomes an increasingly deficient nutrient. Therefore, maintaining high crop yields when the frequency of cropping is increased requires higher rates of nitrogen fertilizer, manure or frequent inclusion of legume crops in the rotation. This greater need for nitrogen does not indicate that continuous cropping is more detrimental to the soil than crop-fallow rotations. The additional nitrogen required to maintain yields in continuous cropping systems helps to maintain soil organic matter.

Frequent fallowing of land leads to the depletion of soil organic matter, exposes the soil to greater loss by wind and water erosion, and on some soils, contributes to increased salinity. From the standpoint of soil conservation, fallowing should only be practised when soil moisture reserves are inadequate for recropping.

Available **phosphorus** levels in Alberta soils are variable but usually in the moderately deficient range. Unlike nitrogen, phosphorus levels do not change quickly as a result of cropping, soil management practices or climate. Application rates of phosphorus fertilizer should reflect the available phosphorus status of individual fields, the requirements of the crop to be grown, and the general growing conditions.

The level of available phosphorus in soils can gradually be increased by the application of moderate to high rates of phosphorus fertilizer, and manure. Crop rotations that maintain or improve soil organic matter levels can also increase phosphorus availability. Topsoils contain much higher levels of available phosphorus than subsoils. Therefore, management practices that reduce wind and water erosion will help to maintain soil phosphorus.

Potassium and **sulphur** deficiencies are not as widespread as nitrogen and phosphorus deficiencies but deficiencies are common in particular areas and soil types. If crop yields are low and responses to nitrogen and phosphorus fertilizers appear small, attempts should be made to determine what other factors are limiting crop yields. Soil testing and field test strips are good methods of determining if potassium and sulphur are deficient.

Additional information on potassium and sulphur is contained in Agdex 542-9. *"Potassium Fertilizer Application in Crop Production,"* and Agdex 542-10, *"Sulphur Fertilizer Application For Crop Production."*

Micronutrient fertilizers, which include chlorine, boron, copper, iron, manganese, zinc and molybdenum, are not generally required for crop production in Alberta but some micronutrient deficiencies have been noted in the province. These include: i) manganese deficiency in oats under cold, wet soil conditions, ii) boron deficiency in canola and alfalfa on a few Gray Wooded and sandy soils, iii) copper deficiency on some organic and mineral soils in central and northern Alberta, and iv) zinc deficiency mainly on irrigated field beans in southern Alberta. General use of micronutrient fertilizers is not recommended. Micronutrients should only be applied in situations where a specific deficiency has been

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identified. Additional information on micronutrients is contained in Agdex 531-1, *"Micronutrient Requirements of Crops in Alberta,"* and Agdex 532-2, *"Copper Deficiency in Alberta."*

Cropping and Soil Management in the Major Soil Groups

There is a wide range of soil types and climatic conditions within the province. Cropping practices and fertilizer use generally reflect the growing conditions in the major soil zones as shown on the map (Page 3).

Brown Soils

Brown soils occur in the semi-arid short grass prairie region of the province where the annual precipitation is about 30 cm. There are about five million acres of dryland cultivation and seven million acres of native range within the Brown soil zone. Dryland farming consists mainly of wheat-fallow rotations. Moisture is the most limiting factor to crop production. Stubble cropping is not recommended unless there is greater than 75 cm of moist soil on medium textured (loam) soils or 55 cm on fine textured (clay) soils. Minimum or conservation tillage is required to reduce wind erosion and conserve moisture.

Dark Brown Soils

Dark Brown soils occur in the prairie region where the average annual precipitation is about 35 cm. There are about eight million acres of Dark Brown soils of which almost five million are cultivated. Cropping practices in this area are similar to those in the Brown soil zone but improved moisture conditions allow a greater variety of crops, more frequent cropping of stubble and higher rates of fertilizer. Stubble cropping is not generally recommended unless there is greater than 68 cm of moist soil on medium textured soils, or 50 cm on fine textured soils. Wind erosion and salinity control may necessitate stubble cropping when moisture levels are less than adequate. Conservation tillage practices are required.

Thin Black Soils

Thin Black soils occur as a strip within the Black zone, adjacent to the Dark Brown soils. Soil moisture reserves and summer precipitation have a major influence on yields and fertilizer response. Precipitation is somewhat higher than in the Brown and Dark Brown soil zones. The southern portion of this zone receives more rainfall but the rate of evaporation is higher than in the northern portion. Rainfall is quite variable in this area. Increased production can be realized from adjusting crop rotations and fertilizer rates to match soil moisture reserves. Soil moisture reserves may be increased with reduced tillage.

Black and Dark Gray Wooded Soils of Central Alberta

Moisture is less limiting to crop production in this area than in areas to the south and east. There is little need for fallowing to store soil moisture. Good yields can be obtained under continuous cereal cropping systems with adequate fertilization. Rotations that include grasses and legumes and application of manure are recommended to help maintain soil organic matter and tilth. The higher rates of fertilizer recommended in Table 3 are suggested where previous experience has shown a good response to fertilizer and other management practices are geared to high yields. The relationship between fertilizer costs and crop prices should also provide economic returns that are high enough to offset the higher risk associated with high inputs.

Gray Wooded Soils of Central Alberta

Gray Wooded soils were developed under cool humid conditions and the surface layer is leached of clay and plant nutrients. Soil and organic matter is low and crusting often reduces seedling emergence. Crop rotations that include legumes and grasses help to increase soil organic matter, fertility, and reduce crusting. Summerfallow and removal of cereal crop residues should be minimized. Application of manure is also very effective for increasing the productivity of gray wooded soils.

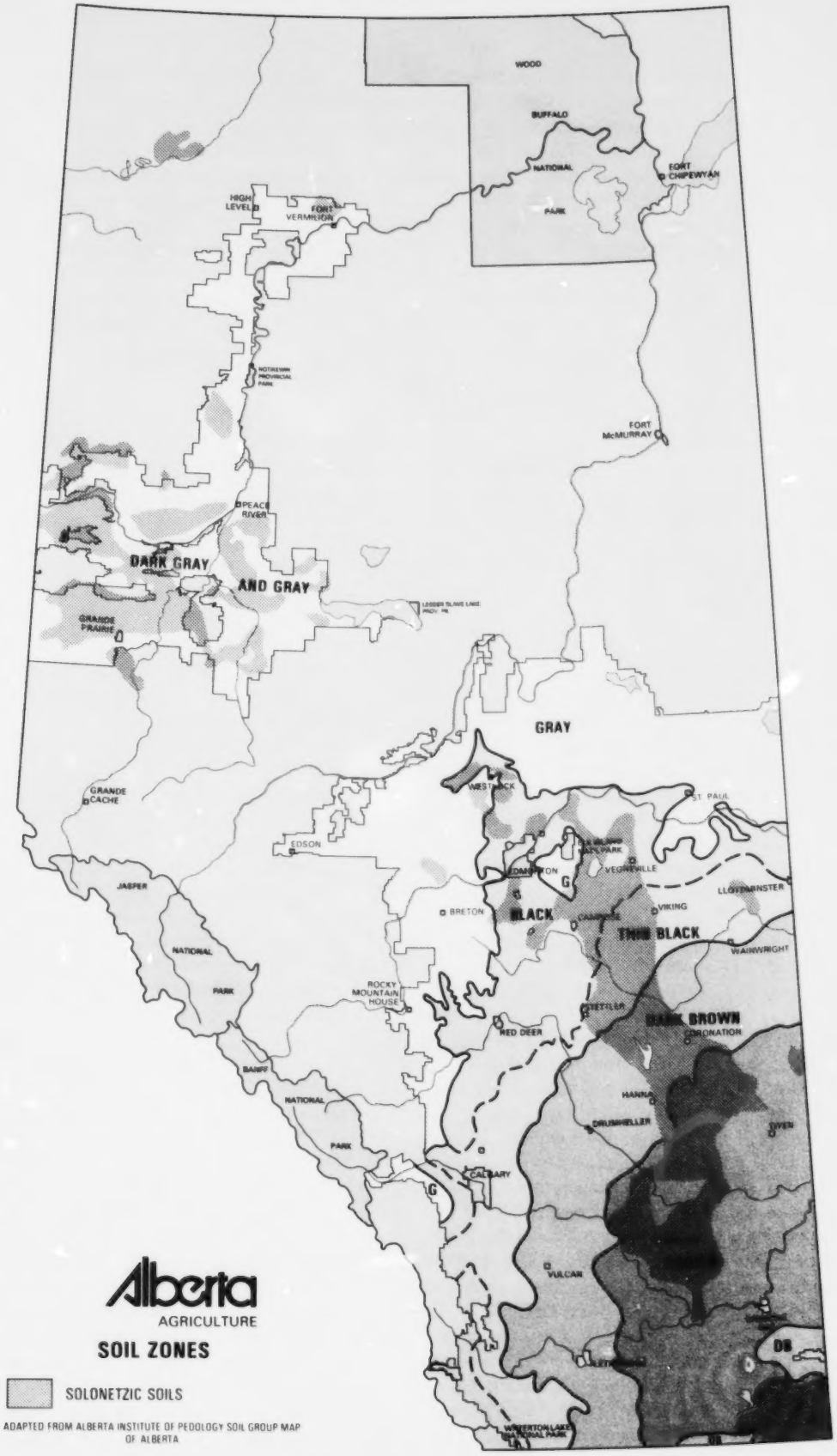
Moisture is not as limiting as elsewhere in Alberta but the growing season is shorter. Nitrogen is often the major limiting factor to high crop yields on Gray Wooded soils.

Many Gray Wooded and some Dark Gray Wooded soils are deficient in sulphur. Legume crops will respond to application of sulphur on one-half to three-quarters of these soils. Cereals and canola may also require additions of sulphur particularly when nitrogen is added. Use of sulphur-containing fertilizers on cereals and canola is advised where a soil is known to show a sulphur response on legume crops or a deficiency is indicated by a soil test.

Dark Gray and Gray Wooded Soils of The Peace River Region and Northeastern Alberta

The agricultural soils in this region range from Black, developed under grassland, to Gray Wooded which developed under forest vegetation. The Black and Dark Gray soils are relatively productive and respond to good management.

The Gray Wooded soils of this region are similar to those in central Alberta, but generally receive less growing season precipitation. Gray soils in the Peace



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SOIL ZONES

SOLONETZIC SOILS

ADAPTED FROM ALBERTA INSTITUTE OF PEDOLOGY SOIL GROUP MAP OF ALBERTA

PRODUCED BY THE RESOURCE EVALUATION AND PLANNING DIVISION, ALBERTA ENERGY AND NATURAL RESOURCES, 1986

region often have a high clay content and are particularly difficult to manage. Cultivation operations have to be timed according to soil moisture content. Poor soil moisture at seeding and soil crusting can reduce yields and fertilizer response. Soil-improving practices such as crop rotations with legumes or grass-legume mixtures, incorporation of crop residues, and addition of manure are helpful for improving the physical condition and reducing surface crusting. Because rainfall is often low during the early growing season, it is important to conserve moisture during seedbed preparation.

Irrigated Soils

There are about one million acres of irrigated land within the irrigation districts in southern Alberta plus some private irrigation systems scattered throughout the province. Soil fertility should be maintained at a level that is adequate to ensure an efficient, high level of productivity which is required to offset the higher production costs associated with irrigation. Soil fertility can be maintained or increased through the use of commercial fertilizers, manure and legume crops.

In addition to maintaining fertility on irrigated soils, cropping practices should be used that prevent the deterioration of soil structure and tilth. Continuous production of row crops such as vegetables, sugarbeets, and corn cause rapid depletion of soil organic matter. Application of manure and crop rotations that include alfalfa, grasses and cereals will help to maintain soil organic matter and tilth.

Crops grown in the Brown, Dark Brown, and Thin Black soil zones in the irrigated areas of southern Alberta respond to nitrogen and phosphorus. Some irrigated soils have received relatively high applications of phosphate fertilizer for many years and may no longer responded to annual applications. These soils require only maintenance applications.

There have been a few instances of small responses to **potassium**, but this nutrient is not generally required.

Sulphur fertilization is not generally required on irrigated soils. There is normally a high level of sulphur in the subsoil and approximately 10 lb/ac of sulphur is added to the soil with each 10 cm application of irrigation water.

Micronutrients are rarely needed on irrigated soils, because the content of micronutrients is sufficient to meet crop requirements. Only zinc deficiencies have been identified and confirmed on some irrigated field beans and occasionally on corn. Zinc, boron, and copper deficiencies have been investigated on a number of other crops but yield increases have either not occurred or have not been consistent.

Recommended rates of fertilizer for a crop vary because of soil type and past management practices. If the fertility of a soil has been built up through the use of manure, legume crops and adequate fertilization, one should use the lower rates of fertilizer in the ranges shown (Table 4). It is possible to get relatively good yields of a crop such as cereals for one year without the use of fertilizer where previous management has included use of manure, legumes, and fertilizer. Soil tests should be used to monitor soil nutrient levels.

Problem Soils

Solonetzic Soils: Solonetzic soils are characterized by a hard-pan layer 5 to 25 cm from the surface. They occur in association with normal soils (see Soil Zone Map) and often cause a typical uneven pattern of crop growth. This wavy growth pattern is particularly noticeable in years when moderate to severe moisture stress occurs because the rooting depth of the crop is restricted. Response to fertilizer on Solonetzic soils is also more variable than on associated normal soils because crop yields are decreased more by moisture stress. Therefore the rate of nitrogen fertilizer should be reduced to 70-80 per cent of the rate used on normal soils. Banded applications of nitrogen are often more effective than broadcast applications on Solonetzic soils.

Acid Soils: Soil acidity causes reduced yeilds of acid-sensitive crops such as alfalfa and barley on many fields in central and northern Alberta. Some 5 to 6 million acres are sufficiently acid to cause reduced yields of alfalfa and one million acres are affected for growing barley.

Acid soils are readily identified by a soil test showing a low pH. The soil reaction is alkaline when the pH value is above 7, neutral at 7, and acid below 7. Crops vary greatly in their tolerance to acidity. Yields of alfalfa are reduced at pH 6 and less, and barley at 5.5 and less. Tolerance to acidity in **decreasing order for annual crops** is: oats, flax, canola, wheat, and barley. Timothy, fescue, red clover, and alsike are among the most tolerant forage crops, while alfalfa and sweet-clover are very sensitive.

Acid soils occur naturally and as a result of the long term use of nitrogen fertilizers. The acidifying properties of nitrogen fertilizer are shown in Table 1. Extensive use of ammonium sulphate (21-0-0) is not recommended on acid soils because of its greater acidifying properties compared to other nitrogen fertilizers. Note, however, that some acid soils are deficient in sulphur so the use of some ammonium sulphate or other sulphur-containing fertilizer may be required.

Application of lime will correct an acid soil condition. Liming is a common practice in many parts of the world used to neutralize acidity caused by natural leaching and the use of nitrogen fertilizers. Productivity of moderately acid soils can also be improved by growing more acid tolerant crops, but the long term solution to improving these soils is the application of lime. See FS 534-1, *Liming Acid Soils.*

Table 1. Acidity of Nitrogen Fertilizers

Fertilizer	Lime ($CaCO_3$) to Neutralize 1 lb of N
	(lb)
Ammonium Sulphate (21-0-0-24S)	5.35
Anhydrous Ammonia (82-0-0)	1.80
Urea (46-0-0)	1.80
Ammonium Nitrate (34-0-0)	1.80

Choosing the Kind and Rate of Fertilizer

The information needed to determine fertilizer requirements is:

1) which nutrient or nutrients are deficient and the degree of deficiency;
2) an estimate of crop response to a given level of fertilizer application, and
3) an assessment of economic returns from fertilizer.

The more accurately these three factors can be determined, the greater is the potential for profitable returns from fertilizer use. Methods of estimating nutrient requirements and crop response are discussed separately for each of the major nutrients (nitrogen, phosphorus, potassium, and sulphur).

Nitrogen

Nitrogen fertilizer requirements for optimum economic returns on crops grown in Alberta cover a very wide range of application rates (Tables 3 and 4). For example, crops grown on fallow will often require little or no additional nitrogen, whereas non-legume crops grown on stubble land can give profitable returns to application rates of 100 lb per ac or more of nitrogen (N). The large range in nitrogen fertilizer requirements result from large differences in the amount of nitrogen supplied by the soil and the amount required by the crop. The yield potential of crops is a major factor affecting nitrogen fertilizer requirements.

1) **Soil nitrogen:** Non-legume crops obtain nitrogen from three main sources: available nitrogen stored in the soil at planting, nitrogen released by the soil during the growing season (from soil organic matter, manure and crop residues), and fertilizer nitrogen. Except for crops grown on fallow, nitrogen stored in the soil plus that released during the growing season is normally insufficient to produce high yields. Because of our short growing season only about one-quarter of the total nitrogen required for high yields of cereal and oilseed crops is supplied from nitrogen released from the soil during the growing season. Therefore, the amount of available nitrogen stored in the soil at planting has a major influence on the amount of nitrogen fertilizer required. A soil test is the most accurate way of determining the available nitrogen status of soils. If soil test results are not available, the cropping history of the field and past experience serve as useful guides.

Fallow fields are not normally considered to be deficient in nitrogen for cereal and oilseed crops, but a significant percentage of samples from fallow fields show a need for additional nitrogen. For example, recommendations based on soil tests indicate that 20 lb/ac or more of nitrogen are required on 30 to 40 per cent of fallow fields. However, the percentage of samples deficient in nitrogen varies widely from year to year.

Stubble fields not recently manured or broken from a legume will usually be low in available nitrogen and require high rates of nitrogen fertilizer to achieve high yields. Stubble fields recently broken from a legume will commonly have an intermediate level of available nitrogen. However, summaries of soil test results indicate large variations can occur from year to year. For example, stubble fields testing low in available nitrogen ranged from 25 to 85 per cent over a 10 year period.

Past experience, cropping history, and general recommendations are useful guides to nitrogen fertilizer requirements, but the wide variation in available nitrogen that can occur from year to year provides a strong argument for the use of soil testing to help determine nitrogen fertilizer requirements.

2) **Estimating crop response to nitrogen fertilizer:** To assess economic returns from fertilizer, an estimate of the increase in yield from a given rate of application must be made. The following factors will influence crop response to applied nitrogen.

(a) **Available nitrogen** in the soil at planting time is one of the main factors that will influence crop response to nitrogen fertilizer. The nitrogen status of a field can be estimated from the previous cropping history, but is more accurately determined by a soil test.

(b) **Soil moisture reserves** and growing season precipitation have a major influence on crop yields and the response to nitrogen fertilizer. In the Brown,

Dark Brown, and Thin Black soil zones, soil moisture reserves should be considered when choosing fertilizer rates. On medium textured (loam) soils in the Brown and Dark Brown soil zones, moist soil to a depth of 75 cm and 68 cm respectively is considered adequate for cropping stubble land. On fine textured (clay) soils in the Brown and Dark Brown soil zones, moist soil to a depth of 55 cm and 50 cm respectively is considered adequate for recropping. When soil moisture reserves exceed these levels, higher rates of nitrogen will usually give positive economic returns. If the entire rooting zone (90-120 cm) is moist, rates twice those normally recommended may be profitable.

(c) **Weed competition** lowers the yield potential of the crop and competes for the nitrogen fertilizer that has been applied. The higher rates of nitrogen recommended will usually not be profitable when weed competition is severe.

(d) **Delayed or late seeding** usually decreases yield response from nitrogen fertilizer. The yield potential of the crop is reduced and the crop can make greater use of nitrogen released by the soil during the later part of the growing season. There is also greater risk of crop loss from frost and poor harvest conditions.

(e) **Crop varieties** with higher yield potential will generally respond to higher rates of nitrogen application than those with lower yield potential, providing that other factors are not limiting.

Economic returns from nitrogen fertilizer are easily calculated if a reliable estimate of crop response over a range of application rates can be made. Some soil testing laboratories provide predictions of the increase in yield from applied nitrogen based on the test for available nitrogen, soil type, location, the previous crop, and crop to be grown. Farmers can then use these yield increase predictions in conjunction with their own past experience, current moisture reserves, fertilizer and crop prices, etc. to determine the rate of fertilizer to apply.

3) **Assessing returns from fertilizer:** An important factor to consider when choosing fertilizer rates is the effect of annual changes in fertilizer and crop prices on net returns. Comparisons from year to year can be made by using a "typical estimate of the increase in yield from fertilizer, and applying the current fertilizer and crop prices (Table 2). In these examples net returns (value of increased yield minus fertilizer cost) range from $24.40/ac to $115.10/ac. Note that changes in crop prices have had a much greater effect on net returns than fertilizer costs.

If the increase in yield from fertilizer can be estimated over a range of application rates, the best method of selecting a rate of fertilizer is to use an economic decision rule which states "Add another unit of a resource as long as the value of product added by that unit is greater than its cost." In the language of economics, the value of the product added is called the value of the marginal product (VMP) and the cost of resource added is called the marginal factor cost (MFC). Applied to fertilizer use, the economic rule states that, net returns (will increase to the point where the cost of an additional increment of fertilizer equals the value of the increased yield. However, when calculating returns from fertilizer application, we are using "estimates" of crop prices and responses to fertilizer (risk and uncertainty). Fertilizer application rates should attempt to optimize profits and minimize risk. Therefore, it is generally recommended that increments of fertilizer be added to a point where VMP (value of increased crop yield) is 1.5 to 2 times greater than MFC (cost of an additional increment of fertilizer).

Some soil testing labs provide estimates of the increase in yield for a range of fertilizer rates thus allowing the calculation of VMP and MFC. Detailed discussion of how to use this economic decision making rule for choosing fertilizer rates is provided in publications, *"How to Get the Most from your Soil Test Results* (Agdex 533) and *"Making Production Decisions"* (Agdex 818-35).

Phosphorus

Soil phosphorus: Unlike nitrogen, available phosphorus levels tend to be characteristic of individual fields or soil types and do not vary widely from year to year owing to previous management. The rate of phosphorus required will depend on the available phosphorus level of the field, the phosphorus requirement of the crop to be grown, and growing conditions. For non-irrigated crops, phosphorus fertilizer requirements are generally higher in central and northern Alberta than in southern Alberta. Cool wet conditions early in the growing season enhance response to phosphorus fertilizer. Also, phosphorus fertilizer often results in earlier and more uniform maturity which is more important in central and northern regions where the growing season is shorter.

Crop response and rates of application: Phosphorus fertilizer requirements can be obtained from the general recommendation tables but they are more accurately determined by a soil test or field test strips. As illustrated in Figure 1, crop response to phosphate fertilizer occurs over a narrower range of application rates than for nitrogen. Note that a response is obtained to the initial 10-15 lb/ac of phosphate even on soils testing moderately high in available phosphorus, and on soils testing low in phosphorus most of the response is achieved at 40-50 lb/ac. Phosphate application rates therefore range between 10 and 50 lb/ac. In contrast, an economic response to nitrogen is seldom obtained on soils testing high in available nitrogen but rates of 100

Table 2. Effect of Fertilizer and Crop Prices on Returns from Fertilizer

Crop and Year	Price (tonne)	Price (bu)	Increase in Yield From Fertilizer* (bu/acre)	Value of Increased Yield ($/acre)	Fertilizer Cost ($/acre)	Net Returns ($/acre)	$return/ $invested in fertilizer
				(a)	(b)	(a-b)	(a÷b)
WHEAT							
1983	$172.69	$4.70	20.2	$ 94.94	$22.50	$ 72.44	$4.22
1986	$ 95.53	$2.60	20.2	$ 52.52	$24.05	$ 28.47	$2.18
1989	$176.37	$4.80	20.2	$ 96.96	$22.00	$ 74.96	$4.41
BARLEY							
1983	$117.12	$2.55	32.3	$ 82.36	$22.50	$ 59.86	$3.66
1986	$ 68.89	$1.50	32.3	$ 48.45	$24.05	$ 24.40	$2.01
1989	$110.23	$2.40	32.3	$ 77.52	$22.00	$ 55.52	$3.52
CANOLA							
1983	$379.19	$8.60	16.0	$ 37.60	$22.50	$115.10	$5.69
1986	$198.41	$4.50	16.0	$ 72.00	$24.05	$ 47.95	$2.99
1989	$313.05	$7.10	16.0	$113.60	$22.00	$ 91.60	$5.16

Fertilizer prices used - 1983: Nitrogen $.25/lb Phosphate $.30/lb
1986: Nitrogen $.28/lb Phosphate $.29/lb
1989: Nitrogen $.25/lb Phosphate $.28/lb

* Predicted yield increase from 60 lb N/ac and 25 lb P_2O_5/ac in the Black Soil Zone with a moderately low N soil test.

lb/ac or more may be profitable on soils testing low in available nitrogen.

Adjustments in the rate of application of phosphorus should be based on the same factors related to growing conditions and the fertilizer-crop price relationship as discussed for nitrogen. However the adjustments should be proportionately smaller (e.g., a 20-30 lb/ac change in the rate of nitrogen warrants only a 10 lb/ac change in the rate of phosphate). On soils that require only maintenance applications of phosphate, the rate of phosphate application does not have to be changed as the rate of nitrogen is increased or decreased (N and P don't have to be applied at a constant ratio). A 10-15 lb/ac minimum rate of phosphate should be maintained except when the soil test is very high. On soils that are very deficient in phosphorus, such as eroded hilltops, a single plowdown application of 100-200 lb/ac may be beneficial in addition to normal annual applications.

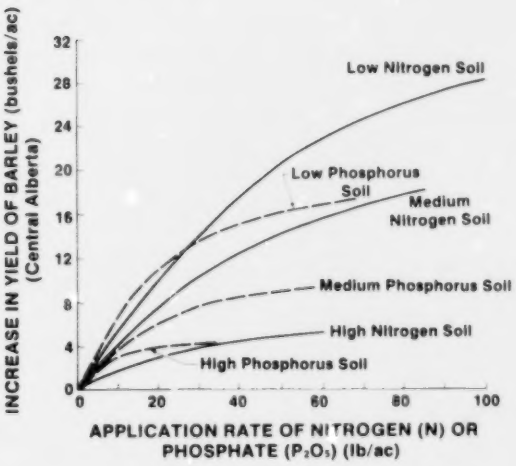

Figure 1. A comparison of response to nitrogen and phosphorus on barley.

Potassium

Potassium deficient soils are not common throughout Alberta but do occur quite frequently in certain areas and soil types. Potassium deficiencies tend to occur on sandy, calcareous soils and soils with poor subsurface drainage adjacent to and on organic soils. Soils testing low in available potassium occur most frequently in west central, northwestern (excluding the Peace region) and northeastern Alberta.

Potassium is a relatively inexpensive fertilizer nutrient and is an important part of an efficient fertilizer program when it is deficient. Barley is somewhat more responsive to potassium than other

Table 3. General Fertilizer Recommendations for Alberta (Rate in pounds per acre of nutrient)

Crop	Previous Crop	Brown ** Nitrogen (N)	Brown ** Phosphate (P_2O_5)	Dark Brown ** Nitrogen (N)	Dark Brown ** Phosphate (P_2O_5)	Thin Black Nitrogen (N)	Thin Black Phosphate (P_2O_5)	Black and Gray Wooded Nitrogen (N)	Black and Gray Wooded Phosphate (P_2O_5)	Black and Gray Wooded Potassium (K_2O)	Sulphur (S)	Application and Placement ***
Spring Wheat	Fallow	5 - 20	10 - 20	5 - 20	15 - 35	5 - 25	15 - 35	5 - 35	15 - 40			Phosphate - place in the seed row or band with nitrogen in fall or spring. Under cool, wet conditions and on low phosphorus soils, placing some phosphate (10-15 lb/ac P_2O_5) with the seed is usually beneficial. Nitrogen - the relative efficiency of fall and spring, broadcast and band applications are shown in Table 6. Maximum rates that can be safely placed in the seed row are shown in Table 5.
	Stubble	20 - 50	0 - 15	25 - 60	0 - 25	35 - 65	10 - 35	30 - 80	15 - 40			
Malting Barley	Fallow	—	—	5 - 15	15 - 35	5 - 25	15 - 35	5 - 35	15 - 40			
	Stubble	—	—	25 - 50	0 - 25	35 - 65	10 - 35	30 - 80	15 - 40			
Oats and Feed Barley	Fallow	5 - 20	10 - 20	5 - 15	15 - 35	5 - 30	15 - 35	5 - 40	15 - 40			
	Stubble	20 - 55	0 - 15	35 - 65	0 - 25	35 - 80	15 - 35	40 - 100	15 - 45			
Fall Rye	Fallow	—	—	25 - 35	20 - 30	25 - 35	20 - 35	5 - 20	20 - 35			Phosphate - place in the seed row or band before seeding. Nitrogen - broadcast early the following spring.
	Stubble	—	—	30 - 55	15 - 25	30 - 60	15 - 30	35 - 70	20 - 35			
Winter Wheat	Fallow	20 - 30	10 - 25	25 - 35	20 - 40	25 - 45	25 - 45	—	—			
	Stubble	25 - 55	10 - 25	30 - 65	15 - 30	40 - 80	20 - 40	—	—			
Flax	Fallow	—	—	5 - 10	10 - 20	5 - 10	15 - 20	5 - 10	15 - 20			Phosphate - band or place in the seed row. Nitrogen - very sensitive to fertilizer placed in the seed row. N should be banded or broadcast.
	Stubble	—	—	20 - 30	0 - 15	20 - 45	0 - 20	20 - 45	15 - 20			
Canola and Mustard	Fallow	5 - 15	10 - 20	5 - 30	15 - 20	5 - 35	15 - 25	5 - 45	15 - 35		0 - 10	Phosphate - a maximum of 25 lb/ac can be placed in the seed row. Band higher rates. Nitrogen - rates higher than 10 lb/ac must be broadcast or banded.
	Stubble	20 -55	10 - 15	35 - 70	15 - 20	30 - 80	15 - 25	40 - 100	15 - 35		0 - 20	
Grass	For Seed	—	—	30 - 60	0 - 15	30 - 70	0 - 30	45 - 90	0 - 40		0 - 10	Broadcast after seed harvest in fall or early spring depending on species. Broadcast fertilizer in late fall or early spring.
	For Forage (with less than 20% legume)	—	—	40 - 90*	0 - 15	60 - 110*	0 - 30	60 - 120	0 - 40		0 - 10	
Grass - Legume	20-40% legume	—	—	30 - 65	0 - 20	40 - 80	0 - 35	45 - 90	0 - 35		0 - 30	Broadcast fertilizer in late fall or early spring.
	40-60% legume	—	—	10 - 30	0 - 35	10 - 30	0 - 45	10 - 30	0 - 50		0 - 30	
Legume	(Greater than 60%)	—	—	0 - 10	0 - 35	0 - 10	0 - 50	0 - 10	0 - 60		0 - 30	A large single application of phosphate (100-200 lb/ac) may be beneficial on low P soils.
Potatoes	Fallow	—	—	—	—	—	—	25 - 50	45 - 90	30 - 60	0	Fertilizer should be banded 3 to 5 cm away from seed row.
	Stubble	—	—	—	—	—	—	70 - 110	55 - 110	30 - 100	0	

*Residual response to the higher rates may persist for two years, particularly when the year of application is dry and production is low. Therefore annual application may not always be necessary.

**See comments regarding soil moisture reserves and their importance in determining crop rotations and choosing fertilizer rates under major Soil Group (page 2) and Choosing the Kind and Rate of Fertilizer (page 5).

***See: Fertilizer - Application and Placement (page 11).

Note:

i) Table 3 should be used in conjunction with the discussion in the text of the publication. Soil tests will provide additional and important information for choosing fertilizer rates.

ii) Blanks — indicate that the crop is not commonly grown or recommended in that soil zone.

iii) See Table 7 for converting from pounds of nutrient to pounds of fertilizer.

cereal crops. Potatoes have a very high potassium requirement and therefore may require potassium fertilization on soils containing adequate amounts for other crops.

Increases in yield from potassium fertilizers are often less visible than for a nitrogen or phosphorus fertilizer. If potassium is tried on a test strip, yields should be measured carefully rather than visually estimated. A comparison of yield with and without potassium should be made where equal and adequate rates of nitrogen and phosphorus are applied. More information on the potassium requirement of crops is contained in publication *"Potassium Fertilizer Application in Crop Production"* (Agdex 542-9).

Crop response to **potassium chloride** (0-0-60 or 0-0-62) has sometimes been observed on soils which are not deficient in potassium by soil tests. Preliminary research indicates these responses may be due to **chloride**. Application of chloride has been shown to reduce root and leaf diseases, but insufficient research has been conducted in Alberta to determine whether crop response can be predicted by a soil test. North and South Dakota use a soil test for chloride as a basis for recommending chloride fertilization. Soil testing laboratories in Alberta may use Dakota criteria as a general guide for chloride recommendations. Field trials should be conducted to establish whether or not the application of potassium chloride is beneficial on soils that are not deficient in potassium.

Sulphur

Some Gray Wooded and Dark Gray Wooded soils and well drained black soils are deficient in sulphur. Sulphur deficiency is not common on Brown and Dark Brown soils. Deficiencies seldom occur in crops grown on fallow, but legume crops, and cereal and oilseed crops that have been well fertilized with nitrogen fertilizer commonly require sulphur fertilization. Sulphur requirements of canola and legumes are greater than for cereals.

The need for sulphur fertilizer can be determined by a soil test. If a test strip is used to determine responses, the comparison with and without sulphur should be made using equal and adequate rates of nitrogen and phosphorus throughout. Sulphur fertilization is inexpensive owing to the relatively **low rate** of application **required** (10-30 lb/ac). Supplying adequate sulphur when it is deficient will usually provide very high returns. More information on the sulphur requirements of crops is contained in publication *"Sulphur Fertilizer Application in Crop Production"* (Agdex 542-10).

Table 4. General Fertilizer Recommendations for Irrigated Crops (Rate in pounds per acre of nutrient)

Crop	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)	Application and Placement*
Wheat - Hard Red Spring	35 - 110	20 - 50	0	Broadcast or band N in fall or early spring (see Table 6). Place phosphate in the seed row or band with N at seeding. Broadcast-incorporated P_2O_5 application should be 2 times the recommended rate at low P soil test levels.
Wheat - Utility & Duram	35 - 110	20 - 50	0	
Wheat - Soft White Spring	35 - 130	20 - 50	0	
Wheat - Winter	35 - 80 (spring applied)	20 - 50	0	
Barley - Feed	40 - 130	20 - 50	0	
Barley - Malting	35 - 130	35 - 50	0	
Barley - Silage	50 - 130	35 - 50	0	
Oats	35 - 80	20 - 50	0	
Fall Rye	30 - 70	20 - 50	0	
Triticale	35 - 90	20 - 50	0	
Canola and Mustard	35 - 140 35 - 110	35 - 60 20 - 50	0	Band or broadcast and incorporate both N and P_2O_5. Maximum amount of P_2O_5 with seed is 20 lb/ac.
Potatoes	90 - 170**	90 - 150	0	Broadcast or band N. Sideband P_2O_5 at seeding.

Table 4. General Fertilizer Recommendations for Irrigated Crops (continued)

Crop	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)	Application and Placement*
Sugar Beets	65 - 110**	55 - 65	0	Broadcast N in fall or early spring. Drill in P_2O_5 (side band) at seeding.
Sweet Corn	45 - 100**	30 - 50	0	Sideband P_2O_5 at seeding. Side dress nitrogen.
Silage Corn	80 - 150	45 - 60	0	Broadcast or band N. Sideband P_2O_5 at seeding.
Grain Corn	80 - 150	30 - 60	0	
Peas	0 - 40	30 - 40	0	Broadcast or band N in fall or early spring. Drill P_2O_5 at seeding.
Beans	10 - 40***	30 - 40	0	Broadcast or band N in fall or early spring. Sideband P_2O_5 at seeding.
Fababeans	0 - 40***	30 - 60	0	Broadcast or band N in fall or early spring.
Soybeans	10 - 30***	20 - 40	0	Drill in P_2O_5 at seeding.
Lentils	10 - 30***	20 - 40	0	
Sunflowers	70 - 135	20 - 60	0	
Flax	20 - 100	15 - 20	0	Broadcast or band N in fall or early spring. Drill in maximum 15 lb/ac P_2O_5 with seed.
Alfalfa	0 - 20***	30 - 60	0	Broadcast in early spring.
Grass - for hay	90 - 150	0 - 60	0	Broadcast 50 to 100 lb/ac N in early spring, follow
Grass - for pasture	110 - 200	0 - 60	0	with 50 lb/ac N in mid-July for maximum production.
Grass - Legume 20% to 40% legume	45 - 90	30 - 60	0	Broadcast fertilizer in early spring. Additional nitrogen (50 lb/ac) may be required in mid-summer to maintain peak production.
Grass - Legume 40% to 60% legume	10 - 35	30 - 60	0	Broadcast fertilizer in early spring.
Legumes (greater than 60%)	0 - 10	30 - 60	0	

Remarks: See Irrigated Soils, page 4.

*Phosphorus is most effective when drilled with or near the seed. Broadcast-incorporated applications should be made 2 to 4 times drilled-in rate to be equally effective at low P soil test levels. Banded phosphorus will be similar to or intermediate between drilled-in and broadcast applications (see page 13 - Phosphorus Placement).

**Nitrogen requirements or coarse textured soils (sandy loam and loamy sand) are usually higher than on fine textured soils (loam, clay loam and clay).

***Fertilizer application rates are based on inoculation with specific rhizobia bacteria to obtain nitrogen fixation.

Fertilizer - Application and Placement

Introduction

The Fertilizer Act requires that fertilizers be labelled according to their guaranteed analysis as percent by weight of nitrogen (N), phosphate (P_2O_5), and potash (K_2O). For example, 100 lb of 11-51-0 contains 11 lb of nitrogen (N), 51 lb of phosphate (P_2O_5), and 0 lb of potash (K_2O). Fertilizer should be purchased on the basis of the price per lb or kg of nutrient not price per tonne of material. For example:

i) if urea (46-0-0) costs $265.00/tonne, the cost per kilogram or pound of nitrogen (N) is:

$$1000 \text{ kg} \times \frac{46}{100} = 460 \text{ kg or } 1014 \text{ lb}$$

$$\frac{\$265.00}{460 \text{ kg}} = \$0.58/\text{kg or } \$0.26/\text{lb of N}$$

(1 tonne = 1000 kg and 1 kg = 2.2 lb)

ii) if ammonium nitrate (34-0-0) costs $220/tonne the cost per kg or lb of nitrogen (N) is:

$$1000 \text{ kg} \times \frac{34}{100} = 340 \text{ kg or } 749 \text{ lb}$$

$$\frac{\$220.00}{340 \text{ kg}} = \$0.65/\text{kg or } \$0.29/\text{lb of N}$$

In this example urea cost more per tonne ($265.00) than ammonium nitrate ($220.00) but cost less per unit of N ($0.26/lb vs. $0.29).

To determine the amount of fertilizer required to supply a given rate of nutrient please refer to Table 7.

Nitrogen Fertilizer

Placement: Nitrogen fertilizers are very soluble and move readily in moist soil. Placement with or very near the seed is not necessary to ensure effective utilization. High concentrations near the seed will cause seedling injury (see Table 5 for maximum rates that can be safely placed in the seed row).

Table 5. Maximum Rate of Nitrogen That Can Be Safely Placed in the Seed Row

			*Double disc or narrow hoe drill		**Pneumatic Seeder 50% spread	
			Source of Nitrogen		Source of Nitrogen	
Crops	Soil Texture	Seedbed Moisture	Urea	Ammonium Nitrate	Urea	Ammonium Nitrate
			lb/ac of Nitrogen (N)		lb/ac of Nitrogen (N)	
Wheat, Oats and Barley	Medium, Fine	Good	30	45	45	65
		Poor	20	30	30	45
	Light (Sandy Loam)	Good	20	30	35	55
		Poor	15	20	25	35
Small seed crops (canola, mustard, flax & cereals underseeded with a legume that is placed in the seed row)	All soil textures	All moisture	10	10	20	35

*Conventional seeder - double disc or narrow hoe opener (1-2 inch spread of seed and fertilizer)
**Pneumatic seeder - cultivator with sweeps at 12 inch spacing giving 50% spread of seed and fertilizer.

Deep-banding (8-15 cm) has become a common method of applying nitrogen fertilizers. Under conditions of low rainfall during the early growing season, deeper placement overcomes the problem of nitrogen being stranded in dry surface soil. Under wet soil conditions that can occur in early spring (during and just after spring thaw), fall applied nitrogen fertilizer can be lost by a process called denitrification. Late fall banding of an ammonium form of nitrogen (i.e. 82-0-0 or 46-0-0) will reduce losses.

Time of application: Fall is often an opportune time to apply fertilizers because of the availability of time and price discounts. However, excessively wet conditions in early spring that sometimes occur on fine textured and poorly drained soils in central and northern Alberta can cause significant losses of fall applied nitrogen. Early fall (before mid-October) broadcast applications are most subject to loss. Late fall banded applications of an ammonium form of nitrogen are less subject to loss. Table 6 shows the

relative efficiency of fall and spring broadcast and banded applications under various conditions.

Top dressing of nitrogen on cereals after emergence is not generally recommended but it can be effective up to the shot-blade stage if adequate rainfall is received after application. Further information is contained in *"Applying Fertilizers Effectively"* (Agdex 542-7).

Table 6. The Relative Effectiveness of Methods and Time of Nitrogen Application for Increasing Crop Yield

Method and Time of Application	Soil-Climatic Categories			
	1 (dry)*	2 (medium)	3 (wet)**	4 (Irrigated)
Spring broadcast and incorporated	100	100	100	100
Spring banded	120	110	105	110
Fall broadcast and incorporated*	90	75	65	95
Fall banded	120	110	85	110

*Although spring and fall banded nitrogen were equally effective in research trials, fall banding may be more practical under farm conditions. The extra tillage associated with spring banding may dry the seedbed and reduce yields.

**In research trials conducted in the higher rainfall areas, spring broadcast nitrogen was well incorporated and seeding and packing completed within a short period of time. Under farm conditions, shallow incorporation or loss of seedbed moisture resulting from deeper incorporation may cause spring broadcast to be somewhat less effective than shown here.

Nitrogen fertilizer sources:

1) Ammonium nitrate (34-0-0):
   - contains nitrogen in both the ammonium and nitrate form
   - less subject to volatilization losses than urea when surface applied without incorporation
   - more subject to leaching losses on sandy soils
   - used with ammonium phosphate to make the common fertilizer grades 23-23-0 and 26-13-0.
2) Ammonium sulphate (21-0-0-24S; 20-0-0-24S and 19-3-0-22S):
   - 22-24% sulphate-sulphur which is the plant available form.
   - used for direct application as both a nitrogen and sulphur source
   - 20-0-0-24S and 19-3-0-22S are granular products more suitable for blending than 21-0-0-24S.
   - more acidifying than other nitrogen fertilizers (Table 1). Therefore, it should not be used continuously or at high rates on acid soils.
   - subject to volatilization losses when not incorporated on high pH soils (pH 7.5 or higher).
3) Urea (46-0-0):
   - highest analysis dry nitrogen fertilizer
   - used for direct application or combines with phosphate to make N-P fertilizer such as 27-27-0 and 17-34-0.
   - more subject to volatilization losses than 34-0-0 when not incorporated into the soil. Significant losses can occur when urea is applied under warm dry conditions to sandy soils, forages with a heavy thatch and on alkaline soils (pH 7.5 or higher).
4) Anhydrous ammonia (82-0-0):
   - highest analysis nitrogen fertilizer
   - suitable for fall or spring application for annual crops
   - must be knifed into the soil to a depth of 8-15 cm.
   - A liquid under pressure which immediately changes to a gas when released into the soil. The soil must close behind the applicator shank to prevent escape of the ammonia gas.

Caution: Anhydrous ammonia is a pressurized gas. Everyone involved in the handling and use of ammonia should be aware of the need for caution.

5) Urea - Ammonium sulphate (34-0-0-11S):
   - contains 11% sulphur
   - supplies adequate sulphur when used as the nitrogen source on sulphur deficient soils.
6) Urea - Ammonium nitrate solutions (28-0-0):
   - a water solution of ammonium nitrate (34-0-0) and urea (46-0-0).
   - solutions lend themselves to uniform application and ease of handling.
   - can be applied through sprinkler irrigation systems.
7) Acid nitrogen solutions (24-6-0-4S and 26-0-0-6S):
   - contain urea, phophoric acid and sulphuric acid
   - ease of handling and uniform application advantages of solutions

- highly corrosive; corrosion resistant materials are required for storage and application equipment.

Phosphate Fertilizer

Phosphate fertilizers do not move readily in soil. Band placement near developing seedling roots of annual crops is most effective. Placement below the depth of seeding may improve availability under dry conditions because the fertilizer is in a moist part of the root zone for a longer period of time than with seed row placement. Broadcast-incorporated applications are less effective than banding with or near the seed for annual crops. Broadcast application should be 2 to 4 times the recommended rates for banding or seed row application.

On established forages, response to broadcast applications may be delayed owing to the slow movement of phosphorus into the root zone. A greater response may occur in the year following application than in the year of application. On soil very deficient in phosphorus, phosphate fertilizer should be banded or incorporated before seeding perennial forages.

Phosphorus fertilizer sources:

1) Monoammonium phosphate (11-51-0, 12-51-0 and 11-55-0):
   - the most common phosphate fertilizers available in Alberta
   - used for seed row or band application on annual crops, broadcast application on perennial forage or blended with nitrogen fertilizers to give various nitrogen-phosphate fertilizers such as 16-20-0, 23-23-0, 27-27-0, and 26-13-0.
2) Other phosphate fertilizer such as diaammonium phosphate (18-46-0), monocalcium phosphate or triple super phosphate (0-45-0), ammonium polyphosphate solution (10-34-0), liquid suspentions made from monoammonium phosphate (10-30-0) and acid solutions made from phosphoric acid and urea (0-34-0-4S) are used to a limited extent in Alberta.

Potassium Fertilizer

Potassium will move in the soil more readily than phosphorus, but for annual crops, potassium fertilizers are more efficient when drilled with the seed or banded. Broadcast applications can be used at about twice the rate used for drill-in application. The maximum amount that may be safely placed with the seed of cereals is 35 lb/ac. For small-seed crops such as canola or flax, the maximum safe rate with the seed is 15 lb/ac. Broadcast or band applications can be made in either fall or spring.

Potassium fertilizer sources:

1) Muriate of potash (0-0-60 or 0-0-62):
   - most commonly used potassium fertilizer in Alberta.
   - used directly as a broadcast application or in blends with phosphorus and nitrogen fertilizers to make fertilizer grades such as 10-30-10, 8-24-24, 13-13-13, etc.

Sulphur Fertilizer

Sulphur in the **sulphate** form moves readily in moist soils. Therefore soluble sulphate fertilizers provide an available sulphur source either as broadcast, drill-in or band applications. Elemental sulphur and gypsum can also be used as sulphur fertilizers.

Sulphur fertilizer sources:

1) Ammonium sulphate (21-0-0-24S, 20-0-0-24S and 19-3-0-22S):
   - contains 22-24% sulphate sulphur
   - used directly as both a nitrogen and sulphur source or combined with ammonium phosphate to produce 16-20-0-14S or with urea to produce 34-0-0-11S.
2) Urea-Ammonium sulphate (34-0-0-11S):
   - contains 11% sulphur
   - not as acidifying as ammonium sulphate and therefore preferable for use on acid soils that are sulphur deficient.
3) Ammonium phosphate-sulphate (16-20-0-14S and 17-20-0-15S):
   - made from monoammonium phosphate and ammonium sulphate
   - common source of nitrogen, phosphorus, and sulphur for broadcast and drill-in application.
4) Sulphur bentonite (90% S):
   - elemental sulphur fertilizers containing 10% bentonite clay.
   - a granular product that can be blended with other fertilizers except ammonium nitrate.
   - elemental sulphur must be converted to sulphate sulphur before it is available to plants. Conversion to the sulphate form is carried out by soil bacteria and requires several months under warm, moist soil conditions. The rate of conversion is very slow unless fine particles of sulphur are mixed into the soil. Band application or incorporation of intact granules results in slow conversion to sulphate. Allowing the granules on the soil surface to be dispersed by rain or freezing and thawing before incorporation, will increase the rate of conversion to sulphate.
5) Gypsum ($CaSO_4$, $2H_2O$):
   - contains 18% sulphur in the sulphate form but is not as soluble as ammonium sulphate
   - supplies both calcium and sulphur.

Table 7. Lb/Ac of Fertilizer Required to Supply a Given Rate of Nutrients

Fertilizer Formulation	lb/ac of Nitrogen (N) Required									
	20	30	40	50	60	70	80	100	120	140
	(lb/ac of fertilizer required)									
21-0-0 (24S)	95	143	190	238	286	333	*	*	*	*
20-0-0 (24S)	100	150	200	250	300	350	*	*	*	*
19-3-0 (22S)	105	158	210	263	316	368	*	*	*	*
34.5-0-0	58	87	116	145	174	203	232	290	348	406
46-0-0	44	65	87	109	133	156	178	217	261	304
82-0-0	24	37	49	61	73	85	98	122	146	171
27-14-0	74	111	148	185	222	259	296	*	*	*
35-15-0	57	86	114	143	171	200	229	286	343	*
23-23-0	87	130	174	217	261	304	*	*	*	*
27-27-0	74	111	148	185	222	259	296	*	*	*
17-20-0 (15S)	118	176	235	294	353	*	*	*	*	*
16-20-0 (14S)	125	188	250	312	375	*	*	*	*	*

Fertilizer Formulation	lb/ac of Phosphate (P_2O_5) Required									
	10	15	20	25	30	35	40	45	50	60
	(lb/ac of fertilizer required)									
11-55-0	18	27	36	45	54	64	73	82	91	109
11-51-0, 12-51-0	20	29	39	49	59	67	78	88	98	118
18-46-0	22	33	43	54	65	76	87	98	109	130
17-34-0	29	44	58	73	88	103	116	131	146	176
8-38-15	26	39	53	66	79	92	105	118	132	158
23-23-0	44	66	87	109	130	152	174	196	217	261
27-27-0	37	56	74	93	111	130	148	167	185	222
16-20-0 (14S), 17-20-0 (15S)	50	75	100	125	150	175	200	225	250	300
27-14-0	71	107	143	179	214	*	*	*	*	*

Fertilizer Formulation	lb/ac of Potash (K_2O) Required							
	10	20	30	40	50	60	80	100
	(lb/ac of fertilizer required)							
0-0-60, 0-0-62	17	33	50	68	85	100	133	167
8-38-15	67	133	200	267	*	*	*	*
8-2-24, 6-24-24	42	83	125	167	208	250	333	417
13-16-10 (11S)	100	200	300	*	*	*	*	*
14-14-7	144	286	*	*	*	*	*	*

Fertilizer Formulation	lb/ac of Sulphur (S) Required						
	5	10	15	20	25	30	40
	(lb/ac of fertilizer required)						
21-0-0 (24S), 20-0-0 (24S)	21	42	62	83	104	125	167
19-3-0 (22S)	23	45	68	91	114	136	182
16-20-0 (14S)	36	71	107	143	180	*	
17-20-0 (15S)	33	67	100	133	167	*	
34-0-0 (11S)	48	95	140	182	*	*	
10-30-10 (5S)	100	200	*	*	*	*	
Gypsum (18S)	27	55	82	110	137	165	
Sulphur bentonite (90S)	*	*	17	22	28	33	44

*Some other fertilizer formulation is more desirable to supply this quantity of nutrient.

Soil Testing and Sampling Guide

Soil testing has become an important tool for assessing soil fertility and arriving at proper fertilizer recommendations. It is also a valuable management aid for studying soil changes resulting from cropping practices and for solving specific cropping problems.

The biggest problem in the effective use of soil testing is proper and representative sampling. The following information is offered to answer special questions concerning soil sampling. Further information and guidance can be obtained by contacting your district agriculturist, fertilizer dealer, or the Agricultural Soil and Animal Nutrition Laboratory, 6909 - 116 St., Edmonton, T6H 4P2.

When to Sample: Cultivated fields for spring seeding should be sampled after October 1. These fields can also be sampled in the spring but time is limited. Fields for fall seeded crops should be sampled one month before seeding. Forage fields for seed, pasture, or hay may be sampled after September 1. Problem soil areas may be sampled anytime. Frozen and water-logged soils should not be sampled because of the difficulty in obtaining a representative sample.

Size Up Your Fields - Each field (with the same crop and management history) must be sampled separately. Size up each field and observe variations in yield and crop growth, texture, color, slope, degree of erosion, drainage, and past treatment. Sample separately sizable areas where growth is significantly different from the rest of the field. Avoid unusual areas such as dead or back furrows, old straw, hay or manure piles, waterways, saline spots, eroded knolls, and old fence rows. Select 15 to 20 sampling sites representative of the portion of the field to be tested.

Sample Tools and Methods: Representative soil samples can best be obtained by using core sampling tools. These are generally available on request from district extension offices and fertilizer dealers. A spade may also be used to take surface samples (0-15 cm). Dig a wedge shaped hole 12 cm deep and remove 2 cm slice of soil from the side of the hole. With a sharp instrument cut away each side of the slice leaving a uniform core (2x2x15 cm) which is collected. The use of a proper sampling tool is essential for sampling to depths below 15 cm. Information on a depth sampler may be obtained from the Agricultural Soil and Animal Nutrition Laboratory. Some fertilizer dealers offer soil sampling services.

Field Samping: Take soil core from 0-15 cm at each of the 15 to 20 sampling sites. For improved nitrogen evaluation or where problem soils are encountered, separate samples should be taken from the 0-15 cm, 15-30 cm, and 30-60 cm depths at 15 to 20 sites. Place cores in clean pails or bags then mix cores taken from same depths, crushing lumps in the process. Keep samples taken from different depths separate from one another.

Dry Soil Samples: Remove half a kilogram air dry to stop nitrate build-up. To air dry, spread a thin layer of soil on a clean piece of paper in a clean room at room temperature. Do not dry with artificial heat.

Packing and Mailing: Place the plastic bag inside the sample box, then fill the box completely. Tie securely and label each box with your name, address, postal code, and measurement of depth of the sample.

Repeat these steps for each uniform field to be sampled. When two or more soil samples are to submitted, place the samples in a shipping container.

Fill Out the Information Sheet: Provide complete information for each soil sample on the sheet supplied. Where unusual problems exist, these should be noted in detail. Keep a completed field plan of the area represented by each sample for your own records.

Submitting Soil Samples: Soil testing is carried out by the provincially operated Agricultural Soil and Animal Nutrition Laboratory and several privately operated laboratories.

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